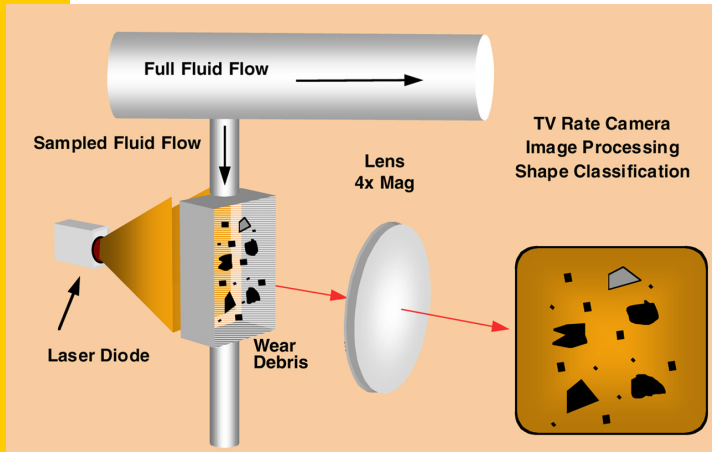


LaserNet Fines Optical Oil Debris Monitor

A New Tool for Condition Based Maintenance

Safety • Affordability • Reliability



Impact

Navy

- Early detection of catastrophic faults
- Enhancement of safety, platform preservation, and mission preservation
- Shipboard operation eliminates remote lab turnaround time and improves asset availability
- Prognosis of remaining useful life
 - Reduced manning, reduced cost (>\$100M/year)

Commercial

- Leverages Navy benefits with application to**
 - Commercial Aircraft
 - Commercial Shipping
 - Rail
 - Off Road Construction
 - Off Shore Oil Drilling
 - Mining

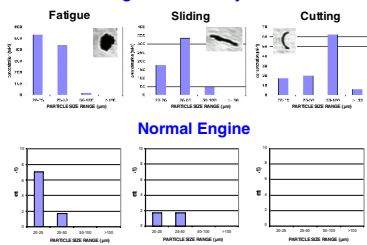
LaserNet Fines Development Time Line

- 1991 Funding from ONR/NAVSEA for Air Vehicle diagnostic System (AVDS) ATD
- 1994 First LaserNet fines patent application submitted
- 1995 NRL demo of first prototype
- Formation of Integrated Product Team with Government participants
- 1996 Funding by ONR under Accelerated Capability Initiative (ACI) on Condition Based Maintenance
- Competitive Selection of Lockheed Martin as commercial IPT member
- Contract to build instrument signed in November
- 1998 First unit shipped in April
- 1999 Lockheed Martin signed patent license for commercialization
- 2000 LNF-M commercial instrument for military application introduced Agreement between Lockheed Martin and Spectro, Inc. for commercial distribution
- 2001 LNF-C instrument for commercial application on market
- FLC award recognizes NRL team for technology transition

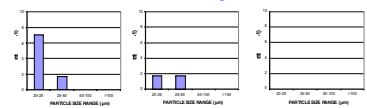
Mechanical Wear in Diesel Engines

LaserNet Fines Provides Direct Signatures of Mechanical Faults Based on Particle Size Distributions in Various Wear Categories

Engine with Heavy Wear



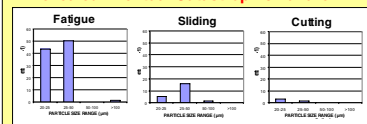
Normal Engine



LaserNet Fines Analysis Could Have Prevented This



LaserNet Test of the 14 Month Old Oil Revealed Eventual Catastrophic Failure



LaserNet Fines Analysis of Hydraulic Systems:

- Provides Absolute Accuracy Traceable to NIST SRM 2806
- Requires No Calibration - Accuracy Fixed by Camera Pixel Size
- Quantifies Water Concentration
- Identifies Abrasives, Oxides, and Fibers
- Classifies Wear Particles - Finds Machine Faults
- Verifies Effectiveness of Maintenance Actions - (Checks Performance of Filters and Clarifiers)

US Army Helicopter Flight Control Hydraulics



Results Summary:

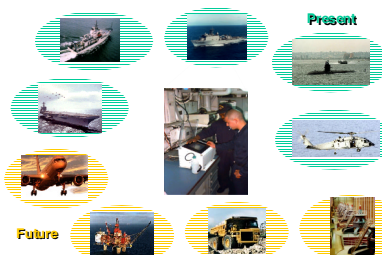
Particle Contamination Level Above Allowable Level

Primary Constituent: MICA

Probable Source: Ingress through SEALS

Recommended Action: Improved Monitoring, Purification When Necessary

LaserNet Fines Platforms



Deployment

- USS RUSHMORE
- R/V Thompson
- Mid Atlantic Regional Test Facility
- Ft. Campbell, KY
- Royal Australian Navy
- Royal Navy

Applications

- Diesel Engine Mechanical Wear
- Aircraft Elevator Hydraulics
- Submarine External Hydraulics
- Helicopter Flight Control Hydraulics
- Helicopter Gearbox Mechanical Wear
- Composite Line Shaft Bearings